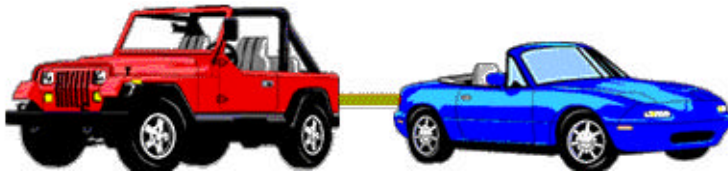


# Balanced and Unbalanced Forces



A **force** is a push or a pull. A force can give energy to an object causing the object to start moving, stop moving, or change its motion.

Forces occur in pairs and can be either balanced or unbalanced. **Balanced forces** do not cause a change in motion. They are equal in size and opposite in direction.

Have you ever had an arm wrestling competition with someone? If you compete against someone who is just about as strong as you are, there will probably be a time when both of you are pushing as hard as you can, but your arms stay in the same place. This is an example of balanced forces. The force exerted by each person is equal, but they are pushing in opposite directions, in this case together. It would look something like this.



Because the force that each of you is exerting is equal, the two forces cancel each other out and the resulting force is zero. Therefore, there is no change in motion.

Another great place to see balanced forces in action is in a tug of war. This is similar to an arm wrestling match, only in this case the forces are moving away from each other. Just like in arm wrestling, if the two teams have equal strength, or force, the rope will stay pretty much in the same place. It would look like this.



Again the resulting force is zero and there is no change in motion.

Unlike balanced forces, **unbalanced forces** always cause a change in motion. They are not equal and opposite.

When two unbalanced forces are exerted in opposite directions, their combined force is equal to the difference between the two forces and is exerted in the direction of the larger force. Look at the following examples to help make this more clear.

Think again about the arm wrestling match. Only this time imagine that you are competing against a world famous body builder. Chances are that his force will be much greater than yours. Your arms will move in the direction he is pushing with a force that is equal to his force minus your force. It will look like this.



Or imagine that you and your friends are having a tug of war with the U.S. olympic weight lifting team. Again their force will probably be a little larger than yours. You will move in the direction they are pulling with a force that is equal to their force minus your force. It will look like this.



Unbalanced forces can also be exerted in the same direction. For example, imagine that your family's car breaks down on the road and you have to push it into a parking lot. If you and your brother or sister both push on the car, the resulting force on the car will be the sum of your forces and of course be in the direction that you are applying the force. The figure below shows how this would work.



Two important things to remember when working with balanced and unbalanced forces are 1) forces in the **same** direction combine by **addition**, and 2) forces in **opposite** directions combine by **subtraction**.

**Try these problems** to test your knowledge about balanced and unbalanced forces.

1. Two tugboats are moving a barge. Tugboat A exerts a force of 3000 newtons on the barge. Tugboat B exerts a force of 5000 newtons in the same direction. What is the combined force on the barge?



2. Draw arrows showing the individual and combined forces of the tugboats in #1.
3. Now suppose that Tugboat A exerts a force of 2000 newtons on the barge and Tugboat B exerts a force of 4000 newtons in the opposite direction. What is the combined force on the barge?
4. Draw arrows showing the individual and combined forces of the tugboats in #3.
5. Could there ever be a case when Tugboat A and Tugboat B are both exerting a force on the barge but the barge doesn't move? Draw arrows showing the individual and combined forces in such a situation.



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